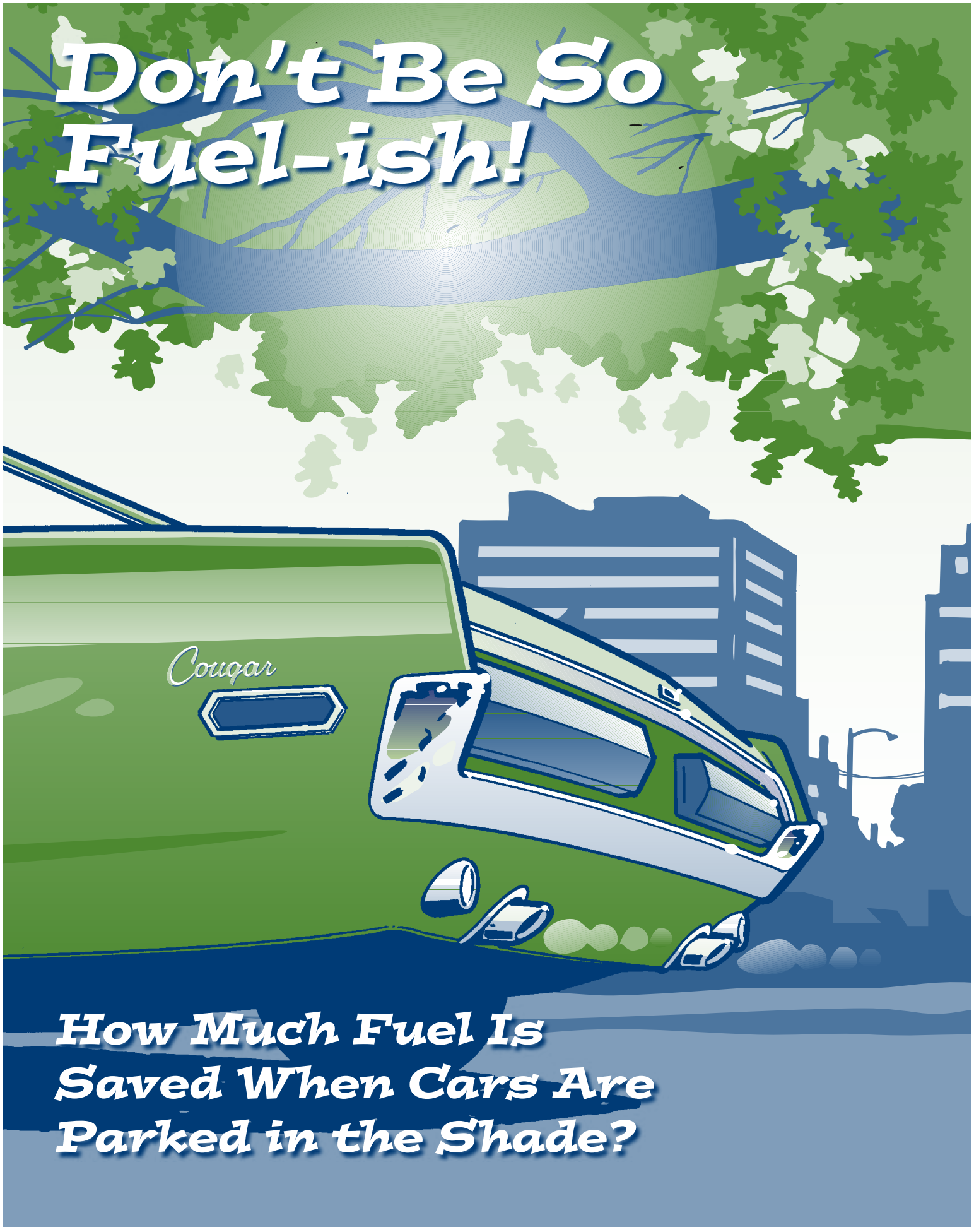
Don't Be So Fuel-ish!



How Much Fuel Is Saved When Cars Are Parked in the Shade?

Meet the Scientists

Dr. Scott: ▲ The most fun I've had as a scientist was the time I operated a "cherry picker" truck to lift a colleague and I up to the top of some pine trees. We were trying to collect some gases *emitted* from pine needles. The truck was the type you might see a technician use to reach telephone lines. We stood cramped together inside the "bucket" with our scientific equipment. It was hilarious. But the view from the tree tops was great.

Dr. Simpson: ▲ One of my favorite experiences in science was to participate in a *meteorological* field study in western Colorado. We camped out in the mountains. We flew on a helicopter to put some of our equipment on surrounding mountain ridges. We also had an opportunity to meet and work with other scientists from all over the United States.

Dr. McPherson: ▲ My favorite science experience is seeing a paper finally in print or giving a presentation to a large group and sensing their interest and excitement. The process of planning and conducting research is long and painstaking. One has to be patient because results don't come quickly. However, the joy of seeing a project completed and knowing that it is valued by others is very gratifying.

Thinking About Science

Scientists sometimes design their experiments so that they can compare different things. In this experiment, the scientists wanted to explore some of the differences between parking lots that are shaded and parking lots that are not shaded. When scientists compare different things, they carefully identify what is similar about and different between the things. (What do you think is similar about and different between these two parking lots?) Scientists then take the same kind of measurement from each thing to see if there are differences. In this study, the scientists were interested in the temperature of each of these two areas.

Thinking About the Environment

Cars use petroleum as a fuel that runs their engines. When the fuel is burned, its energy is transformed into hot gases that leave the car through the tailpipe. The form of the energy in liquid petroleum is different than the form of the energy that comes through the tailpipe. None of the energy is destroyed in the burning process, but it is more spread out and less useable. Burning petroleum as a fuel is an example of the First Law of Energy. This law states that energy cannot be created or destroyed. No matter what kind of energy you can think of, it has to obey this law!

Introduction

You probably know that most of the dangerous gases that come from cars come from the tailpipe while the engine is running. Did you know that cars still produce some gases while the engine is turned off? Parked cars produce more of these gases when the air temperature is hotter than when it is cooler. The scientists in this study wanted to know if cars parked in shady parking lots emit fewer gases than cars parked in sunny parking lots. If that is the case, it would give people another reason to plant trees in parking lots, especially where the *climate* is hot.

Glossary:

meteorological (**me** te or o **loj** uh kôl): Having to do with weather or climate.

emit: (e **mit**): To throw out or eject.

climate (**kli** met): The average condition of the weather over large areas, over a long time, or both.

data (**dat** uh): Facts or figures studied in order to make a conclusion.

Pronunciation Guide

a	as in ape	o	as in go	ü	as in fur
ä	as in car	ô	as in for	oo	as in tool
e	as in me	u	as in use	ng	as in sing
i	as in ice				

Accented syllables are in **bold.**

Method

The scientists parked two identical cars in a parking lot in Davis, California (**figure 1**). One of the cars was parked in the sun. The other was parked in the shade (**figure 2**). The scientists parked the cars facing the same direction. They tried to make both of the parking spaces exactly the same, except for the amount of sunlight hitting each of the cars.

In the shady parking space, the scientists measured the percentage of the sky that was visible when looking up through the tree. In

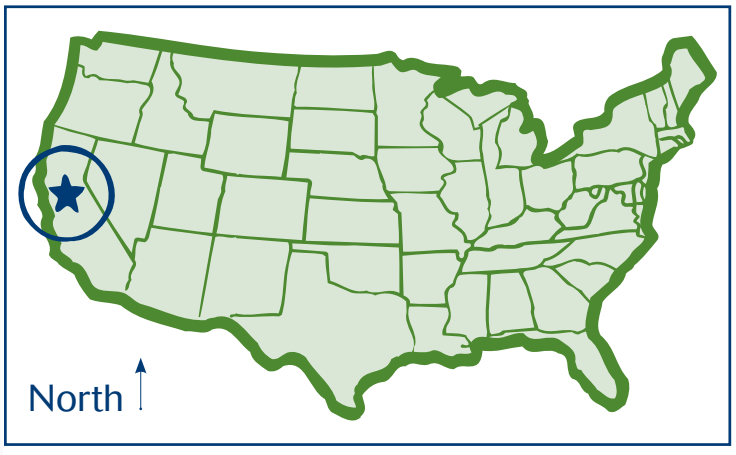


Figure 1. The location of Davis, California

Reflection Section

- Why do you think hotter temperatures cause more gases to be emitted from parked cars?
- What is the question that the scientists were trying to answer?

Figure 2. The cars parked in the parking lot. The cars were dark metal-flake blue 1996 Chevrolet Corsicas.

Figure 3. The instruments collected the data automatically.

both parking spaces, here are the things that they measured:

1. The outside temperature
2. The amount of energy coming from the sun (solar radiation or solar energy)
3. The car's inside temperature
4. The car fuel tank's temperature

The scientists collected this information from August 5 to August 10 when the climate is hot in Davis, California. They used instruments to collect the data automatically every 5 minutes (**figure 3**).

To determine how much dangerous gases were coming from the parked cars at different temperatures, the scientists used mathematical equations that had already been developed. These equations estimated how much gas would evaporate from a parked car at different temperatures. The scientists used a computer to do the calculations, using the temperature data that they collected. The scientists estimated the differences in the amount of evaporating gas under different amounts of shade over the car (**figure 4**). The scientists also compared the cars' surfaces and inside temperatures, fuel tank temperatures,

Figure 4. The scientists collected data under different amounts of shade.

and the amount of the sun's energy reaching each car.

Reflection Section

- Why do you think that the scientists used identical cars?
- Why do you think that the scientists collected their information when the climate was hot?

Findings

The temperature was warmest from August 5-7. **Table 1** shows the differences in temperatures in degrees Celsius on the warmest days. (To calculate the degrees in Fahrenheit, multiply the temperature by 9/5 then add 32).

Only 20 percent of the amount of solar energy reaching the car in the sunny parking space reached the car in the shady space. From the data in **Table 1** and this information on the amount of solar energy reaching the cars, the scientists concluded that the reduction in temperature in the shady parking

Table 1. Temperature differences in the shady and the sunny parking spaces.

Temperatures for Aug. 5-7	Shady Parking Lot ˚C	Sunny Parking Lot ˚C
Average Afternoon Air Temperature	39	40
Average Afternoon Temperature Inside Car	50	65
Average Maximum Fuel Tank Temperature	38.6	41.6

Thinking About Ecology

All living things have environmental limits beyond which they can no longer survive. People, for example, cannot survive long without air, water, or in temperatures that are either too low or too high. In this article, the scientists measured the temperature inside of cars that were parked in the sun and in the shade. The internal temperature of the car parked in the sun was 15^{0}C higher or 27^{0}F higher than the car parked in the shade. Even so, the car parked in the shade, with the windows rolled up, had a temperature of 50^{0}C or 122^{0}F. At this temperature, living things such as people and dogs cannot live for very long. In this article, the scientists were concerned about dangerous gases evaporating from cars. Do you think that these gases have something to do with environmental limits? Why or why not? ■

space was due to the lower amount of solar energy under the tree.

The amount of gas evaporating from the car in the shady parking space was only 2 percent less than from the car in the sunny space. The scientists reported that if the amount of shade over parking lots was increased from 8 percent to 50 percent, the amount of gas evaporating from parked cars would be reduced by 2 percent.

Reflection Section

- From the information in **Table 1**, would you say that the amount of sunlight reaching a parked car has an impact on its inside temperature?
- Do you think that a 2-percent difference is a very big difference in the amount of gas evaporating from a car? Why or why not?

Implications

A 2-percent reduction in evaporation from cars parked in the shade does not seem very large. However, this amount is equal to the amount of fuel that could be saved if printing presses, hospitals, and waste-burning and car scrapmetal businesses throughout the county updated their fuel-burning equipment. Sometimes, just a little bit of improvement can be very important.

The scientists caution that the costs and benefits of planting trees in parking lots need to be determined. It takes money, fuel, equipment, and time to plant and take care of trees. Falling leaves, birds droppings, and falling branches are other things to consider. On the other hand, trees in parking lots keep cars cooler, protect the pavement, protect people from the sun's harmful rays, absorb air pollution, soak up rainwater, reduce the amount of gases evaporating from cars, and make the parking lot more attractive. ■

Reflection Section

- Which would you prefer—a parking lot with trees or one without trees? Why?
- Do you think that evaporation from cars will continue to be a problem in the future? Why or why not?

From Scott, K., Simpson, J. R., and McPherson, E. G. (1999). Effects of tree cover on parking lot microclimate and vehicle emissions. *Journal of Aboriculture* 15(3):129-142.

FACTivity

In this FACTivity, you will answer the question: What is the relationship between temperature, the amount of visible sunlight, and the amount of water evaporating from two identical glass jars?

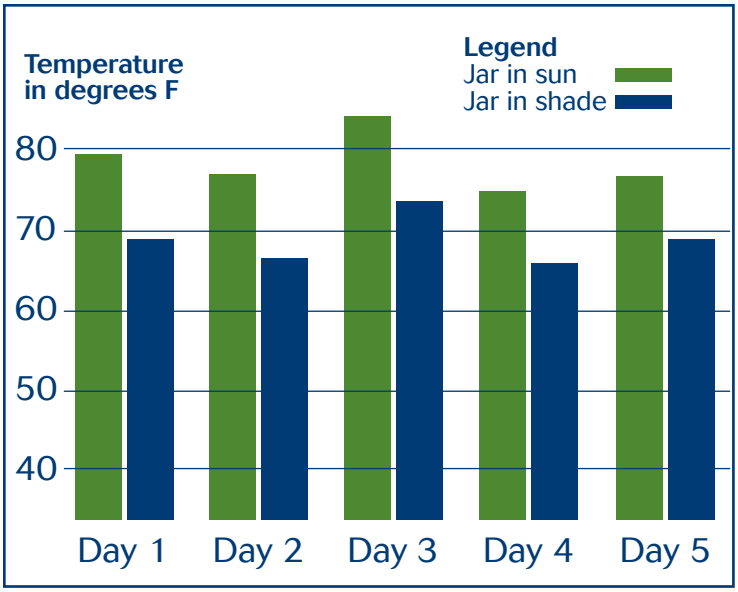
Get two identical glass jars. Mark each of them with a permanent marker at 1/8-inch intervals from 1/8 to 1 inch from the bottom of the jar. Fill the jars with water to the 1-inch mark. Place them on a window sill that receives at least 3 hours of full sun. Place branches of leaves (or pine boughs) near one of the jars so that it is shaded throughout the day.

Get two thermometers. Place them beside the jars. Make sure that the thermometer beside the shaded jar is also shaded.

Every day for 1 week during the sunny time of the day, check the temperature of each jar and the amount of water in the jar. Make a record of your observations. Create a chart for your observations. At the end of the week, compare the temperatures of the two jars and the amount of water in the jars for the entire week. Create two bar charts. One bar chart should display the temperature of the two jars for each day. The second bar chart should display the amount of water in each jar for each day. See the following example.

Discussion—

What is the relationship between the temperature, the amount of sunlight reaching the jar, and the amount of evaporation? Where did the water go? Which jar of water evaporated faster? Why? How is this experiment like the evaporating gas? Where does the gas go? Does the gas or the water lose their energy when they evaporate?



Sample observation chart

	Day 1	Day 2	Day 3	Day 4	Day 5
Jar in Sun— Temperature					
Jar in Sun— Amount of water					
Jar in Shade— Temperature					
Jar in Shade— Amount of Water					